

CLAIMS

What is claimed is:

1. A polyphase filter comprising:
 - a first filter section having an input for receiving signals representative of at least two phases of an input signal, and an output for providing signals representative of at least two phases of a filtered signal, said first filter section having a first passband response;
 - a buffer section having an input coupled to said output of said first filter section, and an output; and
 - a second filter section having an input coupled to said output of said buffer section, and an output for providing an output of the polyphase filter, said second filter section having a second passband response;wherein said first and second filter sections are configured such that said second passband response compensates for said first passband response.
2. The polyphase filter of claim 1 wherein an overall passband response of the polyphase filter is characterized as being substantially flat.
3. The polyphase filter of claim 1 wherein a first one of said first and second filter sections has at least one polyphase filter stage, and a second one of said first and second filter sections has at least two polyphase filter stages.
4. The polyphase filter of claim 3 wherein said signals representative of at least two phases of said input signal comprise a positive in-phase input signal, a negative in-phase input signal, a positive quadrature input signal, and a negative quadrature input signal, and wherein said signals representative of at least two phases of said filtered signal comprise a positive in-phase filtered signal, a negative in-phase

filtered signal, a positive quadrature filtered signal, and a negative quadrature filtered signal.

5. The polyphase filter of claim 4 wherein said first one of said first and second filter sections comprises:

a first resistor having a first terminal for receiving said positive in-phase input signal, and a second terminal for providing said positive in-phase filtered signal;

a second resistor having a first terminal for receiving said positive quadrature input signal, and a second terminal for providing said positive quadrature filtered signal;

a third resistor having a first terminal for receiving said negative in-phase input signal, and a second terminal for providing said negative in-phase filtered signal;

a fourth resistor having a first terminal for receiving said negative quadrature input signal, and a second terminal for providing said negative quadrature filtered signal;

a first capacitor having a first terminal coupled to said first terminal of said first resistor, and a second terminal coupled to said second terminal of said second resistor;

a second capacitor having a first terminal coupled to said first terminal of said second resistor, and a second terminal coupled to said second terminal of said third resistor;

a third capacitor having a first terminal coupled to said first terminal of said third resistor, and a second terminal coupled to said second terminal of said fourth resistor; and

a fourth capacitor having a first terminal coupled to said first terminal of said fourth resistor, and a second terminal coupled to said second terminal of said first resistor.

6. The polyphase filter of claim 4 wherein said buffer section comprises:
 - a first buffer having an input terminal for receiving said positive in-phase filtered signal, and an output terminal;
 - a second buffer having an input terminal for receiving said positive quadrature filtered signal, and an output terminal;
 - a third buffer having an input terminal for receiving said negative in-phase filtered signal, and an output terminal; and
 - a fourth buffer having an input terminal for receiving said negative quadrature filtered signal, and an output terminal.
7. The polyphase filter of claim 4 wherein said second one of said first and second filter sections comprises a plurality of stages, each stage comprising:
 - a first resistor having a first terminal for receiving a positive in-phase input signal, and a second terminal for providing a positive in-phase filtered signal;
 - a second resistor having a first terminal for receiving a positive quadrature input signal, and a second terminal for providing a positive quadrature filtered signal;
 - a third resistor having a first terminal for receiving a negative in-phase input signal, and a second terminal for providing a negative in-phase filtered signal;
 - a fourth resistor having a first terminal for receiving a negative quadrature input signal, and a second terminal for providing a negative quadrature filtered signal;
 - a first capacitor having a first terminal coupled to said first terminal of said first resistor, and a second terminal coupled to said second terminal of said second resistor;
 - a second capacitor having a first terminal coupled to said first terminal of said second resistor, and a second terminal coupled to said second terminal of said third resistor;

a third capacitor having a first terminal coupled to said first terminal of said third resistor, and a second terminal coupled to said second terminal of said fourth resistor; and

a fourth capacitor having a first terminal coupled to said first terminal of said fourth resistor, and a second terminal coupled to said second terminal of said first resistor.

8. The polyphase filter of claim 7 wherein resistances said first, second, third, and fourth resistors of a first one of said plurality of stages are related to corresponding resistances of said first, second, third, and fourth resistors of a second one of said plurality of stages by a predetermined ratio.
9. The polyphase filter of claim 8 wherein said predetermined ratio is about 1:2.5.
10. A polyphase filter comprising:
 - at least three polyphase filter stages wherein a first polyphase filter stage has an input for receiving an input signal, and a last polyphase filter stage has an output for providing a filtered signal;
 - each polyphase filter stage except said first polyphase filter stage having an input coupled to an output of a preceding polyphase filter stage;
 - each polyphase filter stage except said last polyphase filter stage having an output coupled to an input of a succeeding polyphase filter stage; and
 - wherein one of said at least three polyphase filter stages is coupled to another one of said at least three polyphase filter stages by means of a buffer.
11. The polyphase filter of claim 10 wherein an overall passband response of the polyphase filter is characterized as being substantially flat.

12. The polyphase filter of claim 10 wherein said first polyphase filter stage is coupled to a second polyphase filter stage by means of said buffer.
13. The polyphase filter of claim 10 wherein a next to last polyphase filter stage is coupled to said last polyphase filter stage by means of said buffer.
14. The polyphase filter of claim 10 wherein said first polyphase filter stage is characterized as being a passive polyphase filter stage.
15. The polyphase filter of claim 14 wherein said first polyphase filter stage comprises:
 - a first resistor having a first terminal for receiving said positive in-phase input signal, and a second terminal for providing said positive in-phase filtered signal;
 - a second resistor having a first terminal for receiving said positive quadrature input signal, and a second terminal for providing said positive quadrature filtered signal;
 - a third resistor having a first terminal for receiving said negative in-phase input signal, and a second terminal for providing said negative in-phase filtered signal;
 - a fourth resistor having a first terminal for receiving said negative quadrature input signal, and a second terminal for providing said negative quadrature filtered signal;
 - a first capacitor having a first terminal coupled to said first terminal of said first resistor, and a second terminal coupled to said second terminal of said second resistor;
 - a second capacitor having a first terminal coupled to said first terminal of said second resistor, and a second terminal coupled to said second terminal of said third resistor;

a third capacitor having a first terminal coupled to said first terminal of said third resistor, and a second terminal coupled to said second terminal of said fourth resistor; and

a fourth capacitor having a first terminal coupled to said first terminal of said fourth resistor, and a second terminal coupled to said second terminal of said first resistor.

16. A method for filtering an input signal to provide a filtered signal comprising the steps of:

forming signals representative of at least two phases of the input signal;

filtering said signals in a polyphase filter having first and second filter sections having respective first and second passband responses, wherein said first section has an input for receiving said signals and an output, and said second section has an input coupled to an output of said first section and an output;

configuring said first and second filter sections such that said second passband response compensates for said first passband response; and

providing said output of said second filter section as the filtered signal.

17. The method of claim 16 wherein said step of configuring comprises the steps of:

forming a first one of said first and second filter sections with at least one stage, and forming a second one of said first and second filter sections with at least two stages.

18. The method of claim 16 wherein said step of filtering comprises the step of buffering said output of said first section to provide said input of said second section.

19. The method of claim 16 wherein said step of forming signals representative of at least two phases of the input signal comprises the step of forming positive and negative in-phase input signals and positive and negative quadrature input signals.
20. The method of claim 16 wherein said step of providing comprises the step of providing positive and negative in-phase filtered signals and positive and negative quadrature filtered signals.
21. An image rejecting mixer comprising:
 - a first multiplier having a first input for receiving an input signal, a second input for receiving a first local oscillator signal, and an output;
 - a second multiplier having a first input for receiving said input signal, a second input for receiving a second local oscillator signal in quadrature with said first local oscillator signal, and an output; and
 - a polyphase filter having first and second inputs respectively coupled to said outputs of said first and second multipliers, and an output for providing an output of the image rejecting mixer, and comprising:
 - a first filter section having first and second inputs respectively coupled to said outputs of said first and second multipliers, and an output for providing signals representative of at least two phases of a filtered signal, said first filter section having a first passband response;
 - a buffer section having an input coupled to said output of said first filter section, and an output; and
 - a second filter section having an input coupled to said output of said buffer section, and an output for providing an output of the polyphase filter, said second filter section having a second passband response;

wherein said first and second filter sections are configured such that said second passband response compensates for said first passband response.

22. The image rejecting mixer of claim 12 wherein an overall passband response of the polyphase filter is characterized as being substantially flat.
23. The image rejecting mixer of claim 21 wherein a first one of said first and second filter sections has at least one polyphase filter stage, and a second one of said first and second filter sections has at least two polyphase filter stages.
24. The image rejecting mixer of claim 23 wherein said first one of said first and second filter sections comprises said first filter section, and said second one of said first and second filter sections comprises said second filter section.
25. The image rejecting mixer of claim 23 wherein said input of said first filter section comprises a positive in-phase input signal, a negative in-phase input signal, a positive quadrature input signal, and a negative quadrature input signal, said output of said first filter section comprises a positive in-phase filtered signal, a negative in-phase filtered signal, a positive quadrature filtered signal, and a negative quadrature filtered signal.
26. The image rejecting mixer of claim 25 wherein said first one of said first and second filter sections comprises:
 - a first resistor having a first terminal for receiving said positive in-phase input signal, and a second terminal for providing said positive in-phase filtered signal;
 - a second resistor having a first terminal for receiving said positive quadrature input signal, and a second terminal for providing said positive quadrature filtered signal;

- a third resistor having a first terminal for receiving said negative in-phase input signal, and a second terminal for providing said negative in-phase filtered signal;
- a fourth resistor having a first terminal for receiving said negative quadrature input signal, and a second terminal for providing said negative quadrature filtered signal;
- a first capacitor having a first terminal coupled to said first terminal of said first resistor, and a second terminal coupled to said second terminal of said second resistor;
- a second capacitor having a first terminal coupled to said first terminal of said second resistor, and a second terminal coupled to said second terminal of said third resistor;
- a third capacitor having a first terminal coupled to said first terminal of said third resistor, and a second terminal coupled to said second terminal of said fourth resistor; and
- a fourth capacitor having a first terminal coupled to said first terminal of said fourth resistor, and a second terminal coupled to said second terminal of said first resistor.

27. The image rejecting mixer of claim 25 wherein said buffer section comprises:

- a first buffer having an input terminal for receiving said positive in-phase filtered signal, and an output terminal;
- a second buffer having an input terminal for receiving said positive quadrature filtered signal, and an output terminal;
- a third buffer having an input terminal for receiving said negative in-phase filtered signal, and an output terminal; and
- a fourth buffer having an input terminal for receiving said negative quadrature filtered signal, and an output terminal.

28. The image rejecting mixer of claim 25 wherein said second one of said first and second filter sections comprises a plurality of stages, each stage comprising:
- a first resistor having a first terminal for receiving a positive in-phase input signal, and a second terminal for providing a positive in-phase filtered signal;
 - a second resistor having a first terminal for receiving a positive quadrature input signal, and a second terminal for providing a positive quadrature filtered signal;
 - a third resistor having a first terminal for receiving a negative in-phase input signal, and a second terminal for providing a negative in-phase filtered signal;
 - a fourth resistor having a first terminal for receiving a negative quadrature input signal, and a second terminal for providing a negative quadrature filtered signal;
 - a first capacitor having a first terminal coupled to said first terminal of said first resistor, and a second terminal coupled to said second terminal of said second resistor;
 - a second capacitor having a first terminal coupled to said first terminal of said second resistor, and a second terminal coupled to said second terminal of said third resistor;
 - a third capacitor having a first terminal coupled to said first terminal of said third resistor, and a second terminal coupled to said second terminal of said fourth resistor; and
 - a fourth capacitor having a first terminal coupled to said first terminal of said fourth resistor, and a second terminal coupled to said second terminal of said first resistor.
29. The image rejecting mixer of claim 28 wherein resistances of said first, second, third, and fourth resistors of a first one of said plurality of stages are related to

corresponding resistances of said first, second, third, and fourth resistors of a second one of said plurality of stages by a predetermined ratio.

30. The image rejecting mixer of claim 29 wherein said predetermined ratio is about 1:2.5.
31. The image rejecting mixer of claim 21 further comprising a local oscillator having a first output for providing said first local oscillator signal, and a second output for providing said second local oscillator signal.
32. The image rejecting mixer of claim 31 wherein said first and second local oscillator signals have a predetermined frequency chosen to mix said input signal to baseband.
33. A receiver comprising:
 - a first mixer having an input for receiving an RF signal, and an output for providing an intermediate frequency (IF) signal;
 - a first filter having an input for receiving said IF signal, and an output for providing a filtered IF signal;
 - a second mixer having an input for receiving said filtered IF signal, and an output for providing a baseband signal; and
 - a second filter having an input for receiving said baseband signal, and an output for providing a filtered baseband signal;
 wherein said second mixer is characterized as being an image rejecting mixer and comprises:
 - a first multiplier having a first input for receiving said filtered IF signal, a second input for receiving a first local oscillator signal, and an output;
 - a second multiplier having a first input for receiving said filtered IF signal, a second input for receiving a second local oscillator signal in quadrature with said first local oscillator signal, and an output; and

a polyphase filter having first and second inputs respectively coupled to said outputs of said first and second multipliers, and an output for providing an output of the image rejecting mixer, and comprising:

a first filter section having first and second inputs respectively coupled to said outputs of said first and second multipliers, and an output for providing signals representative of at least two phases of a filtered signal, and having a first passband response;

a buffer section having an input coupled to said output of said first filter section, and an output; and

a second filter section having an input coupled to said output of said buffer section, and an output for providing an output of the polyphase filter, and having a second passband response;

wherein said first and second filter sections are configured such that said second passband response compensates for said first passband response.

34. The receiver of claim 33 wherein an overall passband response of the polyphase filter is characterized as being substantially flat.
35. The receiver of claim 33 wherein a first one of said first and second filter sections has at least one polyphase filter stage, and a second one of said first and second filter sections has at least two polyphase filter stages.
36. The receiver of claim 33 wherein said first mixer mixes said RF signal to a fixed IF.
37. The receiver of claim 33 further comprising a low noise amplifier having an input adapted to be coupled to an antenna, and an output coupled to said input of said first mixer for providing said RF signal.

38. The receiver of claim 33 further comprising a programmable gain amplifier coupled between said output of said second mixer and said input of said second filter.